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Trabajo Original

Valoración nutricional

Effect of satiety on body composition and anxiety in university athletes: cohort study

Efecto de la saciedad en la composición corporal y en la ansiedad en atletas universitarios: un estudio de cohortes

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Abstract

Background: Satiety is a determining parameter in nutrient intake control, which in the long run impacts on body weight. Many athletes need strict control on their weight to achieve their aims of the season.

Aim: The aim of this study is to analyse the influence of satiety on body weight control and competitive anxiety in a university athletes population when they ingest *ad libitum* foods (SATIETY), or follow a nutritional dietary programme (DIET).

Methods: The present study was a cohort study, in which 40 male university athletes participated. The assessment of body weight was done using the ISAK recommendations in its limited profile. The study of competitive anxiety was evaluated using the CSAI-2 questionnaire.

Results: Results showed that the DIET group decreased significantly their body weight compared to the SATIETY group, they also obtained a significant improvement in their body composition, reducing fat mass. The SATIETY group didn't show significant reductions in fat mass. This group showed higher competitive anxiety values than the DIET group.

Conclusions: The university athletes that follow an adapted and individualized diet seem to show improvements in their body composition and anxiety compared to those with *ad libitum* food.

Key words:

Dietary intake. Sport nutrition. Psychology. Fat mass. Muscle mass. Exercise.

Resumen

Introducción: la saciedad en un parámetro determinante en el control de la ingesta y que afecta, por tanto, al peso corporal. Muchos atletas necesitan un control estricto del peso para alcanzar sus objetivos deportivos de la temporada.

Objetivo: analizar la influencia de la saciedad en el control del peso y en la ansiedad competitiva en atletas universitarios cuando siguen una dieta libre (SATIETY) o un programa de seguimiento nutricional (DIET).

Métodos: se trató de una cohorte de 40 atletas universitarios varones. La valoración del peso se realizó de acuerdo a las recomendaciones ISAK, mientras que la ansiedad se evaluó con el cuestionario CSAI-2.

Resultados: los resultaron mostraron que el grupo DIET disminuyó significativamente en el peso, comparado con el grupo SATIETY. También se obtuvo una disminución en la masa grasa en el grupo DIET, que no se obtuvo en el SATIETY. Este último grupo obtuvo puntuaciones de ansiedad competitiva superiores.

Conclusiones: los atletas universitarios que siguen una dieta adaptada individualizada parecen mejorar su composición corporal y sus niveles de ansiedad cuando se comparan con los que siguen una dieta libre.

Palabras clave:

Ingesta dietética. Nutrición deportiva. Psicología. Masa grasa. Masa muscular. Ejercicio.

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INTRODUCTION

Satiety is a determining parameter in nutrient intake control, which in the long run impacts on body weight (1). Many athletes need strict control on their weight to achieve their aims of the season. Intense physical exercise temporarily causes ingestion reduction that is accompanied characteristically by physical exercise with the aim of defending the organism against metabolic stress caused by an increase in nutrient demands (2,3).

Appetite is only a part of ingestion behaviour that has many aspects. A sociocultural dimension exists given that people normally eat in groups and all the process is subjected to a circadian rhythm. In this way, although daily energy use isn't measured consciously and varies in function of physical activity, climate and other factors, appetite adjusts to necessities, maintaining stable body weight (4).

The need and wish to fill oneself that is complemented with the added value of pleasure as a consequence of an act of consuming, is produced in neuronal networks that extensively overlap. The pleasure system is associated to cerebral structures that generate consumerist acts. The bases of all of these are the survival mechanisms, where decisions are taken to cover vital needs. Eating is one of these needs. However, since some decades ago, in developed countries, humans maintain a normal weight within strict limits, this is because of a homeostatic process that the organism has (5). When eating starts, the balance between hunger and satiety depends on numerous factors, such as emotional, the time of the day, the hedonic value of foods, social uses, etc. All of this, mostly, escapes homeostatic energy control, allowing us to eat even in absence of the sensation of appetite. However, the instant when ingestion finishes seems to be biologically more controlled, thanks to the mediation of nerve and hormonal signals called by satiety (6). As a result, the nervous system intervenes in the emergence of satiety, advancing or retroceding it and can affect the magnitude of meals and in this way, the quantity of energy consumed. In this manner, the regulation of food intake in the long term is assured by the adjustment of control in short term. For this reason, hunger and appetite and the sensations that they transmit are the episodes in which the organism searches, chooses and ingests food and the phenomenon's that provisionally finalize with ingestion and procure the sensation of satiety (7).

At an intracellular level, the metabolic pathways benefit from the nutrients provided as a result of ingestion that trigger satiety signals. In the homeostasis of the metabolic pathways, the role of certain enzymes is highlighted so that when resting they stimulate the thermogenesis process or use nutrients in a more efficient way when doing an activity (6). Here the involved signals play a leading role in the homeostasis of fatty tissue, like leptin, that is a small circulating peptide secreted by the white adipose tissue, whose synthesis increases when fat mass increases in the organism (8).

Altered psychological states like depression or anxiety are related with abnormal food behaviours, affecting appetite in a great manner and the choice of food. In this way, according to pretensions at psychological or negative emotional levels or anguish, an increment or decrement of ingestion of food or control of satiety can be activated (9).

In this way, in athletes, the event of a sporting challenge influences in the psycho-physiological state of the athlete (10). Intrinsically, it can mean threatening aspects that can convert into a challenge for athletes (11) and the levels of anxiety can increase before sporting events. Anxiety has been considered a negative emotional state (12) as a discouraging emotional reaction that accompanies the arousal of the autonomous nervous system and considered thereby as a dis-adaptive emotional condition. This is a multidimensional construct that is constituted of different components, making a difference between intensity and directionality of anxiety (13), and somatic and cognitive anxiety.

A nutritionally inadequate diet or an adequate control in the diet intake of athletes can also affect processes related with the ingestion of foods and thus, satiety (14). Recent studies show a relation between alterations in food behaviour and the presence of anxiety (15,16). In this regard, an increase in ingestion of ad libitum foods, in absence of hunger, is related with an increment of body weight (17). In terms of sport contexts, an increment of weight at the cost of fat mass, will impact negatively in the performance of athletes during sport practice (18).

Overall, the aim of this study is to determine the influence of satiety on anxiety and body weight control in a university athlete population comparing them in two groups, those that followed a free diet ad libitum and those that followed a supervised nutritional program in order to reach the correct weight. The hypothesis of this study is that satiety plays a determining role in the control of body weight in sport, for this reason, it will be adequate establish dietetic strategies to permit the subjects manage this sensation without generating anxiety states, allowing better control of body weight long term.

METHODS

PARTICIPANTS

This cohort study was in accordance with STROBE (STrengthening the Reporting of OBservational studies in Epidemiology) statements. Forty male volunteers were selected from students of Sport Science and Physical Activity at the Univesidad Miguel Hernández, who practice running in different clubs of Alicante (Spain). Selection criteria included, beginning of the season, to have performed regular aerobic training in the previous season and have a minimal mark of 4 min in 1,000 m, and have a regular running trainings at least 2 days at week from the last 2 years. Study size was arrived at 40 male volunteers that were informed of the objective and demands of the study and gave their written consent to participate. The protocol was in accordance with local legal requirements and the Helsinki Declaration for research on human beings, and approved by the Ethical Committee of Universidad Miguel Hernández.

PROCEDURE

The study performed with athletes consisted in comparing 2 randomized groups (20 athletes each one) following an isocaloric diet

under supervision by our laboratory, but: a group with the possibility of incrementing the intake of foods freely (SATIETY), and the other strictly following our isocaloric diet (DIET). Participants were randomized by a computer-generated number, which was concealed in sequentially numbered, sealed, and opaque envelopes, and kept by a trained nutritionist who delivered the intervention.

All subjects performed a supervised aerobic routine (determined by calibrated pedometers), during 4 weeks and under the supervision of the corresponding coaches and pedometer. No other physical activity was performed during the study.

INSTRUMENTS/MEASURES

Caloric expenditure was theoretically estimated and designed diets were adapted accordingly for each particular subject, divided into 3 components: resting metabolic rate, thermic effect of feeding and physical activity expenditure. Resting metabolism was calculated according to Harris-Benedict equation that takes into account for each gender, the weight in kg, height in cm and the age in years (19). The physical activity expenditure was estimated from published tables (20). Dietetic program for DIET was designed using Dietsource software (Novartis, Barcelona, Spain) and adapted to aerobic training (60% carbohydrates, 25-30% lipids and 10-15% proteins). The free diets followed by the SATIETY group were analysed from daily records provided by participants. The record included the type of food, quantity and moment of the day for consumption.

Anthropometry was performed according to International Society for Advancement of Kinanthropometry recommendations (21). Body fat mass was calculated using Siri's equation (22) from the body density values obtained according to Withers. Bone mass was calculated from Rocha's equation (23,24) and muscle mass from Lee's equation (25).

The percentage or kg of body fat mass, muscle mass and weight at the beginning of the study (PRE) was compared with the percentage or kg of body fat mass at the end of the study (POST). The difference between both values (Δ = POST - PRE) indicated the variation in fat component, muscle component or weight of each volunteer during the study.

CSAI-2 questionnaire (Competitive State Anxiety Inventory-2) (26) was used to determine cognitive anxiety (CA), anguish and loss of concentration related to sport performance; somatic anxiety (SA) refers at activation of the autonomous nervous system that provokes physiological responses and self-confidence (SC), taking into account confidence in skill performance and possibilities for winning (27). In this questionnaire we can obtain intensity and directionality, intensity considers the dimension of CA, SA and SC parameters (values between 1-4; corresponding to none, low, medium, and high, respectively); and directionality refers to the personal appretiation of the athlete and the possible influence in performance (values regarding if the state is harmful (0 to -3) or beneficial (0 to +3) for the athlete). The analysis of internal validity and consistency of the questionnaire (Cronbach's alpha) for the 3 factors that measure intensity was: SA (0.78), CA (0.82) and SC (0.83). In this respect, the Cronbach's alpha of directionality for SA obtained a value of 0.74, 0.80 for CA and 0.73 for SC.

Values of CSAI-2 at the beginning of the study (SA PRE - CA PRE - SC PRE) were compared with the percentage of values of CSAI-2 at the end of the study (SA POST - CA POST - SC POST). The difference between both values (ΔCSAI-2 = %CSAI-2 POST - CSAI-2 PRE) indicated the variation in competitive anxiety component or subscale of each volunteer during the study.

Quantitative variables handled in the analyses were: total body weight, fat mass, muscle mass, CA intensity, CA directionality, SA intensity, SA directionality, SC intensity and SC directionality.

STATISTICAL ANALYSIS

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS, v. 20.0 for Windows). The results were expressed as means ± standard error of the mean (mean ± sem). One-sample K-S test (Kolmogorov-Smirnov test) was performed in order to assess if each variable fits a normal distribution. T-test for independent samples was used to compare means between different groups. Test for related samples was used to compare means in the same group. Same non-parametric test was used to compare means if variables don't have a normal distribution. Pearson correlation test was computed for correlations between anxiety and body composition variables. Statistical significance was set at $p < 0.05$. The effect size were calculated using Cohen's d. ESs were considered negligible (< 0.2), small (0.2-0.50), moderate (0.50-0.80), and large (> 0.80).

RESULTS

All participants included in study, followed the intervention protocol, assessments and concluded each stage of our study. When comparing both groups of athletes, significant differences were observed between both in the variation of weight ($p = 0.004$), where the SATIETY group incremented their weight whilst the DIET group decreased. Although no significant differences were found, the DIET group showed an increase in muscle mass accompanied by a decrease in fat mass, in absolute values (kg) and in relative values (%), contrary to the SATIETY group (Fig. 1). The anxiety results (Fig. 2), found significant differences between both DIET and SATIETY groups in the POST CS intensity values ($p = 0.040$), where the DIET group has higher SC values. Regarding significant differences ($p = 0.043$) between the SA intensity between the two groups, the DIET group showed a fall in the SA levels whilst the SATIETY group increased these levels at the end of the study.

On one hand, when comparing the subjects within each of the groups, the DIET group before and after the intervention, have shown a significant decrease in both total body weight ($p = 0.016$) and fat mass in absolute (kg) ($p = 0.045$) and relative (%) ($p = 0.044$) values (Fig. 1) with moderate ES. However, in the rest of the studies variables there were no significant differences.

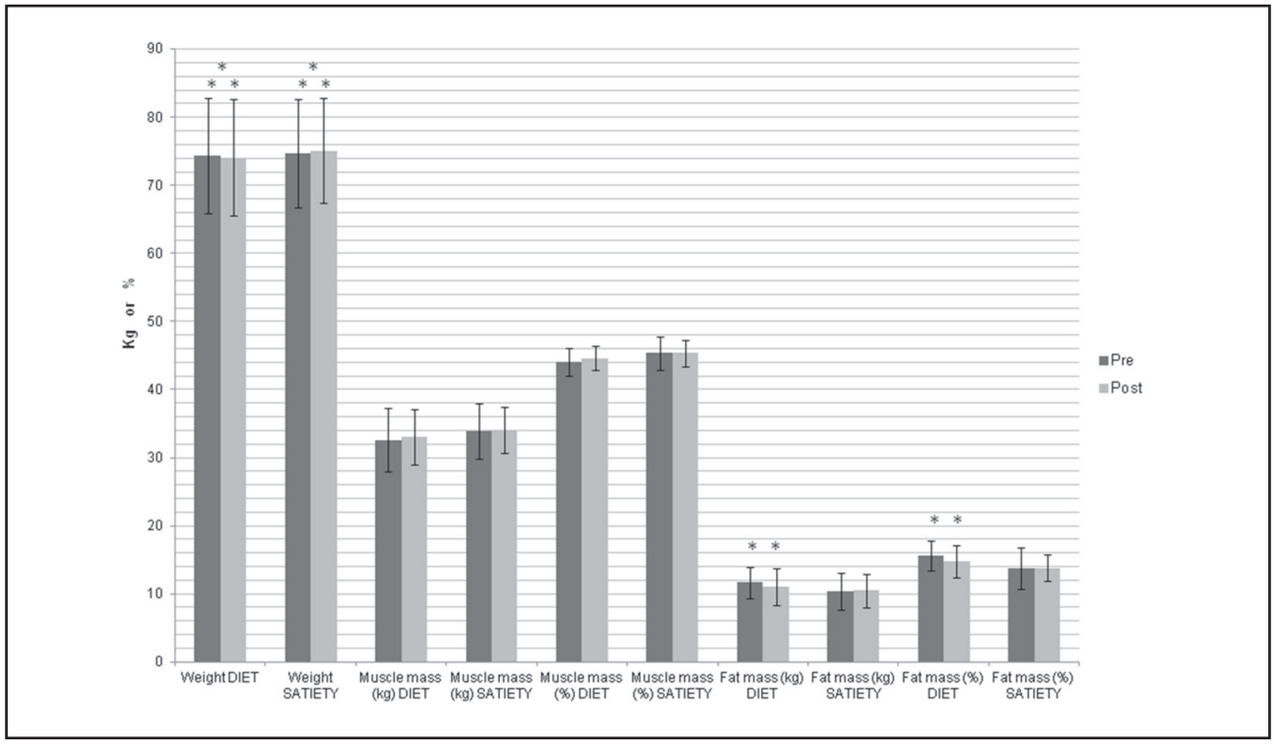
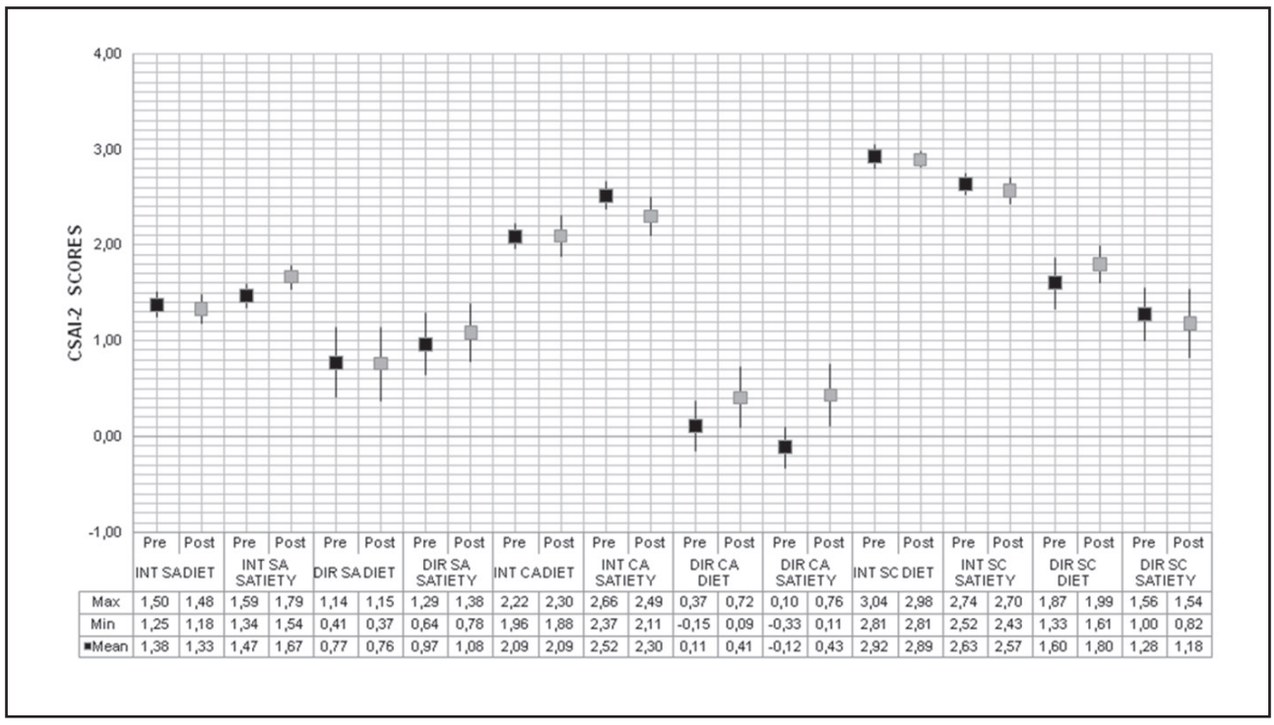


Figure 1.

Body composition assessment PRE and POST intervention on DIET and SATIETY groups (*pvalor < 0.05; differences between DIET and SATIETY groups; **pvalor < 0.05; differences between PRE and POST evaluation into the same group).



	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
	INT SA DIET		INT SA SATIETY		DIR SA DIET		DIR SA SATIETY		INT CA DIET		INT CA SATIETY		DIR CA DIET		DIR CA SATIETY		INT SC DIET		INT SC SATIETY		DIR SC DIET		DIR SC SATIETY	
Max	1,50	1,48	1,59	1,79	1,14	1,15	1,29	1,38	2,22	2,30	2,66	2,49	0,37	0,72	0,10	0,76	3,04	2,98	2,74	2,70	1,87	1,99	1,56	1,54
Min	1,25	1,18	1,34	1,54	0,41	0,37	0,64	0,78	1,96	1,88	2,37	2,11	-0,15	0,09	-0,33	0,11	2,81	2,81	2,52	2,43	1,33	1,61	1,00	0,82
Mean	1,38	1,33	1,47	1,67	0,77	0,76	0,97	1,08	2,09	2,09	2,52	2,30	0,11	0,41	-0,12	0,43	2,92	2,89	2,63	2,57	1,60	1,80	1,28	1,18

Figure 2.

Competitive anxiety assessment: Competitive State Anxiety Inventory-2 (CA: cognitive anxiety; SA: somatic anxiety; SC: self-confidence; DIR: directionality; INT: intensity).

On the other hand, the SATIETY group also presented significant differences in the total body weight (p = 0.046), having incremented after the intervention (Fig. 1). Also, significant differences were found in the SA intensity (p = 0.031) and the CA directionality (p = 0.033), producing in both a significant post intervention increase, both with moderate ES (Table I).

After making correlations between the different variables in both groups, the DIET group showed a significant correlation between the increment of fat mass percentage and CA intensity (R = -0.612; p = 0.046), the lower the muscle mass increment, the higher the CA intensity in the DIET group. In the rest of the variables, no significant differences were found. Furthermore, in the SATIETY group, significant correlations were observed between the increment of muscle mass and the CA directionality (R = -0.715; p = 0.020), in percentage (R = -0-72; p = 0.017) and also the CA directionality, in this case in a negative form.

DISCUSSION

Body weight is a determining parameter in sport performance. Achieving an optimal weight for a better adaptation to sport isn't an easy task. Diets don't seem to achieve the desired results, although they seem to be well designed, they generate anxiety states in the subjects, especially if they have to lose weight. Moreover, many sport groups lack professional services to plan correct diets.

Even though, in the present study no significant differences have been highlighted, it seems that the DIET group has an increased predisposition in exhibiting modification in body composition that favours sport performance. The obtained results show that following an adequate, individualized nutritional dietary programme that is adapted to each athlete, helps them to decrease their weight in a significant form compared to those who ingest food freely. This fact coincides with the importance of satiety control to control body weight (1). Also, this weight reduction influences on fat mass in a significant form without muscle mass being affected in the DIET group.

Table I. Difference between both values (Δ = POST - PRE) indicated the variation in body composition assessment or competitive anxiety of each group during the study

	DIET			SATIETY		
	Mean		SD	Mean		SD
Δ Weight	-0,27	±	0,31	0,36	±	0,51
Δ Muscle mass (kg)	0,46	±	0,90	0,18	±	1,83
Δ Muscle mass (%)	0,65	±	1,42	-0,02	±	2,56
Δ Fat mass (kg)	-0,60	±	0,86	0,11	±	1,77
Δ Fat mass (%)	-0,85	±	1,28	0,09	±	2,58
Δ SA Intensity	-0,05	±	0,28	0,20	±	0,24
Δ SA Directionality	-0,01	±	0,41	0,12	±	0,32
Δ CA Intensity	0,02	±	0,49	-0,22	±	0,44
Δ CA Directionality	0,30	±	0,48	0,55	±	0,69
Δ SC Intensity	-0,03	±	0,33	-0,07	±	0,20
Δ SC Directionality	0,20	±	0,75	-0,10	±	0,64

In the SATIETY group, the results obtained from an increment in the SA intensity could be due to the fact that the subjects are conscious that they probably haven't used the most adequate nutritional dietary strategies to achieve an improvement in their body composition and sport performance, as they have had no limits when ingesting food along the day. For this reason, it is necessary that athletes follow an adapted diet to their particular energetic needs, so that they can replace lost energy through exercise, however, without exceeding the replenishment as this increments total body weight, as seen in the results of this present study; as an increment of weight that isn't exclusively of muscle mass will negatively impact on sports performance.

In this way, it seems that in the sample of studied athletes, appetite can be altered by energetic needs and body weight isn't always maintained, in opposition to other studies (4,5). Likewise, it is necessary to highlight the influence of psychological aspects as a conditioning factor of satiety mechanisms (9).

The results obtained in the correlations of the DIET group, reveal the importance of body composition values regarding the CA intensity level. Furthermore, regarding the correlations of the SATIETY group, it seems that as the body composition improves in relation to muscle mass and fat mass parameters, the CA directionality increments favourably which benefits sport performance (28). In this regard, the athletes show at cognitive level that a favourable body composition is favourable when doing sporting events.

It seems evident that anxiety is a factor that influences on sport performance (29). However, there are many theories that associate different parameters of anxiety with opposite effects on performance. The first tendencies focused on decreasing anxiety and increasing SC to achieve higher sporting success (30). In our study, after the intervention, the DIET group achieved higher SC intensity levels than the SATIETY group, which could be because the nutritional dietary strategies help athletes to cope with ease the sporting challenge in question, also having a higher control at cognitive level of their own possibilities and confidence in their abilities. The differences between the DIET and SATIETY groups in relation to the increment of the SA intensity, highlights that those athletes that don't control their diet show a series of impacts at a psychological level, that can influence at a physiological level like tension increments at muscle level, stomach upsets and increases in sweating and heartbeats (31).

It has been proven that stressful situations or anxiety states can affect our food behaviours, influencing in the choice and ingestion of food, like in satiety mechanisms. Moreover, it seems that elevated anxiety levels, seen in the SATIETY group in the current study, also corresponds with an excess of food intake, equally seen in other scientific studies (9).

The fact that no significant differences were found in the different fat and muscular compartments of the body composition between the studied groups could be due to the reduced number of the sample and differences between athletes in metabolism and exercise adaptations. Because of these limitations, the need to do an intervention incrementing the number of athletes and the control of metabolic parameters in both DIET and SATIETY group is highlighted. In this way, other limitation of this study was the absence of gas analyzer to measure oxygen uptake to assess the energy cost (METs), and data could be converted to units of energy expenditure (METs). Furthermore the control of body composition by DXA and blood biomarkers could also provide complementary information. Also, it could have been interesting to do specific tasks that assess physical performance, like exercise tests that are useful for objectively evaluating body composition changes with the intention of correlating them with better performance. However, these tests were not done in the present study.

In conclusion, athletes that followed a specific nutritional dietary programme show favourable modifications in body composition without showing higher levels of competitive anxiety. A diet without controlling satiety mechanisms could produce an increment in competitive anxiety.

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